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PATENT TRADEMARK OFFICE

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/AU00/01115	14 SEPTEMBER 2000	14 SEPTEMBER 1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

LASER ASSISTED THERMAL POLING OF SILICA BASED WAVEGUIDES

TITLE OF INVENTION

1. Wei XU; 2. Danny WONG; 3. Graham TOWN; 4. John CANNING; 5. Paul BLAZKIEWICZ

APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE. The completion of those filing requirements that can be made at a time later than 30 months from the priority date results from the Commissioner exercising his judgment under the authority granted under 35 USC 371(d) The filing receipt will show the actual date of receipt of the last item completing the entry into the national phase. See 37 C.F.R.

CERTIFICATION UNDER 37 C.F.R. 1.10*
*(Express Mail label number is **mandatory**)*
(Express Mail certification is optional)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date FEBRUARY 11, 2002, in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number EV011020553US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

CONNIE YANNOTTI
(type or print name of person mailing paper)

Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C F R 1 8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

***WARNING:** *Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing 37 C F R 1 10(b)*
*"Since the filing of correspondence under § 1 10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

§1.491 which states "An international application enters the national state when the applicant has filed the documents and fees required by 35 USC 371(c) within the periods set forth in § 1 494 and § 1.495."

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C F R §1 10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C F R §1.8.*

NOTE *Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111 37 C F R § 1.494(f).*

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2.Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS*	15- 20 =		x $ 18.00 =	$
	INDEPENDENT CLAIMS*	2- 3 =		x $ 84 00 =	
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $280.00				
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... $100.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $710.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U S PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO. [ ] has been paid (37 CFR 1.492(a)(2)) ..... $740.00 [X] has not been paid (37 CFR 1.492(a)(3)) ..... $1,040.00 [ ] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $890.00				
	Total of above Calculations				=1040.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Statement may also be filed. (note 37 CFR 1.9, 1.27, 1.28)				-
	Subtotal				1040.00
	Total National Fee				$1040.00
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$1040.00

*May include Preliminary Amendment (see page 8) reducing the number of claims.

i. [X] A check in the amount of $1040.00 to cover the above fees is enclosed.
ii. [ ] Please charge Account No. _____ in the amount of $ _____.
A duplicate copy of this sheet is enclosed.

***WARNING:* *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date. * * * (2) the basic national fee (see § 1 492(a)) The 30-month time limit may not be extended " 37 C F.R. § 1.495(b)*

WARNING *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office 37 C F R § 1 495(b)(2). The payment of the surcharge set forth in § 1 492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date The payment of the processing fee set forth in § 1 492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date Failure to comply with these requirements will result in abandonment of the application The provisions of § 1 136 apply to the period which is set Notice of Jan 3, 1993, 1147 O.G. 29 to 40*

[ ] Applicant hereby asserts status as a small entity under 37 C.F.R. § 1.27.
[ ] A Statement or Written Assertion is attached.

NOTE: *37 C F R. § 1.27(c) deals with the assertion of small entity status, whether by a written specific declaration thereof or by payment as a small entity of the basic filing fee or the fee for the entry into the national phase as states*

"(c) Assertion of small entity status Any party (person, small business concern or nonprofit organization) should make a determination, pursuant to paragraph (f) of this section, of entitlement to be accorded small entity status based on the definitions set forth in paragraph (a) of this section, and must, in order to establish small entity status for the purpose of paying small entity fees, actually make an assertion of entitlement to small entity status, in the manner set forth in paragraph (c)(1) or (c)(3) of this section, in the application or patent in which such small entity fees are to be paid.

(1) Assertion by writing Small entity status may be established by a written assertion of entitlement to small entity status. A written assertion must.

(i) Be clearly identifiable,

(ii) Be signed (see paragraph (c)(2) of this section); and

(iii) Convey the concept of entitlement to small entity status, such as by stating that applicant is a small entity, or that small entity status is entitled to be asserted for the application or patent While no specific words or wording are required to assert small entity status, the intent to assert small entity status must be clearly indicated in order to comply with the assertion requirement

(2) Parties who can sign and file the written assertion The written assertion can be signed by:

(i) One of the parties identified in §§ 1 33(b) (e g , an attorney or agent registered with the Office), §§ 3 73(b) of this chapter notwithstanding, who can also file the written assertion,

(ii) At least one of the individuals identified as an inventor (even though a §§ 1.63 executed oath or declaration has not been submitted), notwithstanding §§ 1 33(b)(4), who can also file the written assertion pursuant to the exception under §§ 1 33(b) of this part, or

(iii) An assignee of an undivided part interest, notwithstanding §§ 1 33(b)(3) and 3 /73(b) of this chapter, but the partial assignee cannot file the assertion without resort to a party identified under §§ 1 33(b) of this part

(3) *Assertion by payment of the small entity basic filing or basic national fee The payment, by any party, of the exact amount of one of the small entity basic filing fees set forth in §§ 1 16(a), (f), (g), (h), or (k), or one of the small entity basic national fees set forth in §§ 1 492(a)(1), (a)(2), (a)(3), (a)(4) or (a)(5), will be treated as a written assertion of entitlement to small entity status even if the type of basic filing or basic national fee is inadvertently selected in error*

(i) *If the Office accords small entity status based on payment of a small entity basic filing or basic national fee under paragraph (c)(3) of this section that is not applicable to that application, any balance of the small entity fee that is applicable to that application will be due along with the appropriate surcharge set forth in §§ 1.16(e) or §§ 1 16(l).*

(ii) *The payment of any small entity fee other than those set forth in paragraph (c)(3) of this section (whether in the exact fee amount or not) will not be treated as a written assertion of entitlement to small entity status and will not be sufficient to establish small entity status in an application or a patent "*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE. Section 1 495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20 At the same time, the International Bureau notifies applicant of the communication to the Office In accordance with PCT Rule 47 1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date " Notice of Jan 7, 1993, 1147 O.G 29 to 40, at 35-36 See item 14c below

a. [ ] is transmitted herewith.
b. [ ] is not required, as the application was filed with the United States Receiving Office.
c. [X] has been transmitted
   i. [X] by the International Bureau.
   Date of mailing of the application (from form PCT/IB/308): _____.
   ii. [ ] by applicant on _____.
   Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):
a. [ ] is transmitted herewith.
b. [X] is not required as the application was filed in English.
c. [ ] was previously transmitted by applicant on _____.
   Date
d. [ ] will follow.

5. [X] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 C F R § 1 495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended The Notice further advises that, "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments Applicant may submit that subject matter in a preliminary amendment filed under section 1 121 In many cases, filing an amendment under section 1 121 is preferable since grammatical or idiomatic errors may be corrected" 1147 O G 29-40, at 36.

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
   i. [ ] by the International Bureau.
   Date of mailing of the amendment (from form PCT/IB/308): _____.
   ii. [ ] by applicant on _____.
   Date
c. [X] have not been transmitted as
   i. [X] applicant chose not to make amendments under PCT Article 19.
   Date of mailing of Search Report (from form PCT/ISA/210):
   15 November 2000.
   ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [X] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
a. [ ] is transmitted herewith.
b. [ ] will follow
c. [ ] is not required as the amendments were made in the English language.
d. [X] has not been transmitted for reasons indicated at point 5(c) above.

7. [X] A copy of the international examination report (PCT/IPEA/409)
[X] is transmitted herewith.
[ ] is not required as the application was filed with the United States Receiving Office.

8. [X] Annex(es) to the international preliminary examination report
a. [X] is/are transmitted herewith.
b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [X] A translation of the annexes to the international preliminary examination report
a. [ ] is transmitted herewith.
b. [X] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
    a. [ ] was previously submitted by applicant on _____ (Date).
    b. [ ] is submitted herewith, and such oath or declaration
        i. [ ] is attached to the application.
        ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.
    c. [X] will follow.

Other document(s) or information included:

11. [X] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
    a. [X] is transmitted herewith.
    b. [ ] has been transmitted by the International Bureau.
    Date of mailing (from form PCT/IB/308): _____.
    c. [ ] is not required, as the application was searched by the United States International Searching Authority.
    d. [ ] will be transmitted promptly upon request.
    e. [ ] has been submitted by applicant on _____ (Date).

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
    a. [ ] is transmitted herewith.
    Also transmitted herewith is/are:
    [ ] Form PTO-1449 (PTO/SB/08A and 08B).
    [ ] Copies of citations listed.
    b. [X] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
    c. [ ] was previously submitted by applicant on _____ (Date).

13. [ ] An assignment document is transmitted herewith for recording.

A separate [ ] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or [ ] FORM PTO 1595 is also attached.

_____
_____
_____

14. [X] Additional documents:
    a. [ ] Copy of request (PCT/RO/101)
    b. [X] International Publication No. WO 01/20389
        i. [X] Specification, claims and drawing
        ii. [ ] Front page only
    c. [X] Preliminary amendment (37 C.F.R. § 1.121)
    d. [ ] Other

15. [X] The above checked items are being transmitted
    a. [X] before 30 months from any claimed priority date.
    b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized*

NOTE. "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time An authorization to charge all required fees, fees under § 1 17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission Submission of the fee set forth in § 1 17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission " 37 C.F R. § 1 136(a)(3)

NOTE "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C F R § 1 26(a)

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 12-0425.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box*

[ ] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE· Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only

be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C F R § 1 492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[X] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F R § 1.311(b).

NOTE· 37 C F R 1 28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application prior to paying, or at the time of paying issue fee." From the wording of 37 C F R § 1 28(b)· (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[ ] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 25,858

William R. Evans
(type or print name of practitioner)

Tel. No.: (212) 708-1930

P.O. Address

Customer No.: 00140

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26 West 61st Street
New York, N.Y. 10023

Practitioner's Docket No. U 013870-6

CHAPTER II

IN THE UNITED STATES ELECTED OFFICE (EO/US)

PCT/AU00/01115	14 SEPTEMBER 2000	14 SEPTEMBER 1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

LASER ASSISTED THERMAL POLING OF SILICA BASED WAVEGUIDES

TITLE OF INVENTION

1. Wei XU; 2. Danny WONG; 3. Graham TOWN; 4. John CANNING; 5. Paul BLAZKIEWICZ

APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington, D.C. 20231
ATTENTION: EO/US

PRELIMINARY AMENDMENT

Please amend the above identified application as follows:

IN THE CLAIMS :

Please cancel claims 13 and 14.

Please amend claims 3, 5, 7, 8, 10, and 12 as follows:

3. (Amended) A method as claimed in claim 1 wherein a direction of th electric field is changed as the laser beam is scanned over the region.

CERTIFICATE UNDER 37 1.10

I hereby certify that this paper is being deposited with the United States Postal Service on this date FEBRUARY 11, 2002 in an envelope as "EXPRESS MAIL POST OFFICE TO ADDRESSEE" Mailing Label Number EV011020553US addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231

CONNIE YANNOTTI
(Type or print name of person mailing paper)

Connie Yannotti
(Signature of person mailing paper)

NOTE: Each paper or fee referred to as enclosed herein has the number of the "EXPRESS MAIL" mailing label place thereon prior to mailing 37 CFR 1.16(b).

5. (Amended) A method as claimed in claim 1 wherein the electric field and/or laser are controlled to effect a non-uniformly poled structure in the region.

7. (Amended) A method as claimed in claim 1 wherein the laser beam is an IR laser beam.

8. (Amended) A method as claimed in claim 1 when applied to a waveguide in the form of an optical fibre.

10. (Amended) A method as claimed in claim 8, when applied to an optical fibre in which the core comprises germanosilicate co-doped with phosphorous.

12. (Amended) An optical device incorporating a silica-based waveguide when thermally poled by the method as claimed in claim 1.

Please add new claim 15 as follows:

15. (Amended) A method as claimed in claim 9, when applied to an optical fibre in which the core comprises germanosilicate co-doped with phosphorous.

Remarks

The above amendatory action is taken solely for the purpose of avoiding claim fees that would otherwise accrue due to the presence of multiple dependent claims.

Respectfully submitted,

WILLIAM R. EVANS
LADAS & PARRY
26 WEST 61ST STREET
NEW YORK, NEW YORK 10023
REG.NO.25,858 (212)708-1930

MARKED UP COPY

3. (Amended) A method as claimed in [any one of the preceding claims] claim 1 wherein a direction of th electric field is changed as the laser beam is scanned over the region.

5. (Amended) A method as claimed in [any one of the preceding claims] claim 1 wherein the electric field and/or laser are controlled to effect a non-uniformly poled structure in the region.

7. (Amended) A method as claimed in [any one of the preceding claims] claim 1 wherein the laser beam is an IR laser beam.

8. (Amended) A method as claimed in [any one of the preceding claims] claim 1 when applied to a waveguide in the form of an optical fibre.

10. (Amended) A method as claimed in [either] claim 8 [or claim 9], when applied to an optical fibre in which the core comprises germanosilicate co-doped with phosphorous.

12. (Amended) An optical device incorporating a silica-based waveguide when thermally poled by the method as claimed in [any one of claims 1 to 11] claim 1.

LASER ASSISTED THERMAL POLING OF SILICA BASED WAVEGUIDES

Field of the invention

The present invention relates broadly to a method and apparatus for thermal poling of materials and to devices incorporating poled materials.

Background of the invention

The induced variation of the electro-optic (EO) coefficient of materials (hereinafter referred to as poling) has been attempted e.g. for optical fibres and bulk glass to produce a residual EO coefficient chi(2) in the glass material.

Two main methods are presently applied for poling optical fibres or bulk glass: (I) thermal poling and (II) ultraviolet (UV) poling. The latter is believed to effect poling through non-thermal effects caused by UV absorption in the glass.

In both methods, a high poling voltage is applied across the material during either the heating process or the UV absorption to produce the EO coefficient changes.

The largest values of the EO coefficient in glass have been produced by UV poling. However, the resulting EO variations have been difficult to reproduce and the underlying principles are not fully understood, which makes this method unsuitable for mass-production of poled materials.

Thermal poling involves the heating of the entire bulk glass or optical fibre in an oven. However, this method has been typically limited to uniform poling. For non-uniform poling, periodic electrodes have to be deposited onto e.g. the bulk glass.

This has required the heating to be performed in a vacuum to prevent smearing between adjacent poling domains by reducing electrical conductivity in air between the electrodes. This results in a complex poling system and furthermore, the periodic poling design of e.g. poled gratings was limited by the photolithographic mask used for

the deposition of the electrodes. Furthermore, as the sign of the EO coefficient can only be changed by applying a poling voltage of different polarity, this is practically impossible with such a poling system, since at the high voltages required, shortening between adjacent electrodes would occur.

Summary of the invention

A first aspect of the present invention provides a method of thermally poling a silica-based waveguide, comprising the steps of:

- exposing a region of the waveguide to an electric field;

- directing a laser beam into the region which is exposed to the electric field;

- irradiating the region at a power density selected to effect localised heating of the waveguide within the region through direct absorption of the laser radiation; and

- scanning the laser beam over the region.

The method may further comprise scanning the laser beam across the region to effect poling of the region.

The method may comprise varying the power density of the laser beam while scanning. Accordingly, a method of non-uniform thermal poling can be provided.

A direction of the electric field may be changed as the laser beam is scanned over the region. Accordingly, it can be possible to alternate the sign of the EO coefficient in non-uniform thermal poling.

Where the material comprises glass, the laser beam is preferably an infrared (IR) laser, for example a CO_2 laser.

Where the material is an optical fibre, wires may be inserted into tubular holes extending substantially parallel to a core of the optical fibre located between the tubular holes, and a differential voltage may be applied to

the wires to create the electric field. The core of the optical fibre may comprise a germanosilicate material co-doped with phosphorous.

A second aspect of the present invention provides an apparatus for thermally poling a silica-based waveguide, comprising:

- a means for exposing a region of the waveguide to an electric field;

- a means for directing a laser beam into the region which is exposed to the electric field;

- a means for irradiating the region at a power density selected to effect localised heating of the waveguide within the region through direct absorption of the laser radiation; and

- a means for scanning the laser beam over the region.

A third aspect of the present invention provides an optical device incorporating a silica-based waveguide when thermally poled by the above-described method.

Preferred forms of the invention will now be described, by way of example only, with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 shows a schematic drawing of an experimental set-up embodying the present invention.

Figure 2 shows a plot illustrating positive poling as a function of time embodying the present invention.

Figure 3 shows a plot illustrating negative poling as a function of time embodying the present invention.

Detailed Description of the Preferred Embodiments

In Figure 1, a Mach-Zehnder interferometer 10 was used for in situ measurement of the evolution of the EO coefficient in an optical fibre 12. The optical fibre 12 is a twin hole fibre with a germano silicate core codoped

with phosphorous. The hole diameter is 108 micrometer and the hole-to-hole spacing was 16 micrometer.

A translation stage 14 is used to scan a CO_2 laser beam from a CO_2 laser 18, using a mirror 20 to direct the laser beam 16 onto the fibre 12.

Aluminium wires 22, 24 were inserted via side entries (not shown) into each of the holes of the twin hole fibre 12 to provide electrodes for applying a poling voltage across the core of the optical fibre 12.

The wires 22, 24 were connected to a DC high voltage power supply 26. During the experiments, a poling voltage of 3.5 kW was applied.

A high voltage AC signal generator 28 is provided in series with the DC power supply 26. The high voltage AC signal generator 28 was utilised as a means to measure the EO coefficient of the core of the optical fibre 12 as follows.

Whilst the DC component of the high voltage acts as the poling voltage, the AC signal (8.5 kHz) can be used to effect refractive index changes in the core of the optical fibre due to the electro-optic effect. As the EO coefficient of the core of the optical fibre 12 changes, so does an AC component of the output of the Mach-Zehnder interferometer 10. The output of the Mach-Zehnder interferometer 10 is measured through a differential amplifier set-up 30 and analysed by a computer 32.

In the arm 34 of the Mach-Zehnder interferometer 10 which does not include the optical fibre 12 a linear ramp phase modulator 36 is used to get around thermal drift instabilities of the Mach-Zehnder interferometer during the experiment in a known manner.

The scan time for scanning the laser beam 16 along the approximately 7 cm of the optical fibre 12 was set at 55 seconds.

Turning now to Figure 2, a typical EO evolution achieved during exposure of the fibre 12 (Figure 1) with a

positive applied high voltage. During a first period 40 when the DC high voltage and the laser beam are turned off, no EO effect is observable, which is characteristic for glass, which does not exhibit a measurable EO coefficient.

When the poling voltage is applied in the next segment 42, the EO coefficient jumps to a positive value (44). In the next segment 46 the laser beam is unblocked and the scan begins (whilst the poling voltage remains applied), and the quantity (EO coefficient*length of scanned fibre) grows rapidly during of the plot. In other words, the cumulative electrooptic phase shift caused by the fibre increases as the length of poled fibre increases during the scan.

When the scan ends and the laser beam is blocked again, the EO coefficient stops growing and remains substantially constant during the next segment 48, whilst the DC poling voltage remains applied.

Finally, upon turning the poling voltage off, a residual EO coefficient 50 remains, in the case illustrated in Figure 2 the residual EO value 50 is approximately 2.03 pm/V.cm. At the end of the scan, the EO coefficient is the same at any point along the scanned region, i.e. 2.03 pm/V.cm divided by 7 cm (the scanned length) = 0.29 pm/V.

(We note that during the entire measurement of the plot illustrated in Figure 2, the AC signal remains being applied to measure the EO coefficient).

Turning now to Figure 3, negative poling will now be described.

Again, initially when the poling voltage and the laser beam are turned off, only a noise level is measured in the first segment 60 of the plot shown in Figure 3, as expected for glass.

In the next segment 62, when the DC poling voltage is turned on, the EO coefficient jumps to a substantially constant value 64, we note that the sign of the EO coefficient is opposite to the EO coefficients in Figure 2

due to a poling voltage of different polarity being applied during the negative poling experiment.

In the next segment 66 of the plot shown in Figure 3, the laser beam is unblocked and the scan begins, the quantity (EO coefficient*length of scanned fibre) decays but remains non-zero.

When the scan ends and the beam is blocked, the EO coefficient stops decaying and maintains substantially constant whilst the poling voltage is still applied during segment 68 of the plot shown in Figure 3.

Finally, when the poling voltage is turned off, a residual (negative) EO coefficient 70 remains, in this case -0.91 pm/V.cm.

Applications

Non-uniformly poled waveguides such as optical fibres can be used for the fabrication of quasi-phase-matched (QPM) optical devices. The phase matching condition can be satisfied by choosing the correct period for a periodic poled grating.

QPM can be realised in glass and optical fibres using the present invention by for example varying the polarity of the applied poling voltage between different regions that are being poled.

Quasi-Phase-Matched gratings can be used for optical frequency mixing and optical switches.

The efficiency of frequency conversion is dependent on the amplitude of the EO coefficient variations in the gratings over the poled length of a waveguide. This has limited the application of poled gratings for frequency conversion, since the EO coefficient variations are typically small, especially in thermal poling.

However, with the present invention, the efficiency of the frequency conversion can be increased because it is now possible to produce poled gratings that are for example metres long, thereby in its cumulative effect overcoming the deficiency problem.

With the method of the present invention, relatively high EO coefficients have been poled in relatively short times compared to thermal poling, which typically requires a time of 10 minutes at 280°C with a 3.5 kV poling voltage to achieve EO coefficients of 0.15 to 0.2 pm/V, i.e. smaller than the EO coefficients achieved with the present invention within 55 seconds.

This can enable rapid poling of optical fibres for commercial manufacture, where for example the CO_2 laser is used to rapidly heat up silicate glass while a poling voltage is applied across the glass as described above.

Furthermore, if a twin-hole optic fibre with electrode wires already in the holes is drawn this enables poling of optical fibres either before or during the drawing of the fibre whilst applying a voltage across the two embedded electrode wires. This could allow very long lengths of poled optical fibre to be produced.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

The claims defining the invention are:

1. A method of thermally poling a silica-based waveguide, comprising the steps of:

- exposing a region of the waveguide to an electric field;

- directing a laser beam into the region which is exposed to the electric field;

- irradiating the region at a power density selected to effect localised heating of the waveguide within the region through direct absorption of the laser radiation; and

- scanning the laser beam over the region.

2. A method as claimed in claim 1 wherein the laser is controlled to such that the power density of the laser beam is varied while scanning.

3. A method as claimed in any one of the preceding claims wherein a direction of the electric field is changed as the laser beam is scanned over the region.

4. A method as claimed in claim 3, wherein the direction of the electric field is reversed as the laser beam is scanned over the region.

5. A method as claimed in any one of the preceding claims wherein the electric field and/or laser are controlled to effect a non-uniformly poled structure in the region.

6. A method as claimed in claim 5 wherein the electric field and/or laser are controlled to effect a periodic poled structre.

7. A method as claimed in any one of the preceding claims wherein the laser beam is an IR laser beam.

8. A method as claimed in any one of the preceding claims when applied to a waveguide in the form of an optical fibre.

9. A method as claimed in claim 8, wherein wires are inserted into tubular holes extending substantially parallel to a core of the optical fibre located between the

tubular holes, and a differential voltage is applied to the wires to create the electric field.

10. A method as claimed in either claim 8 or claim 9, when applied to an optical fibre in which the core comprises germanosilicate co-doped with phosphorous.

11. An apparatus for thermally poling a silica-based waveguide, comprising:

- a means for exposing a region of the waveguide to an electric field;
- a means for directing a laser beam into the region which is exposed to the electric field;
- a means for irradiating the region at a power density selected to effect localised heating of the waveguide within the region through direct absorption of the laser radiation; and
- a means for scanning the laser beam over the region.

12. An optical device incorporating a silica-based waveguide when thermally poled by the method as claimed in any one of claims 1 to 11.

13. A method of thermally poling a silica-based waveguide substantially as herein described with reference to the accompanying drawings.

14. An apparatus for thermally poling a silica-based waveguide substantially as herein described with reference to the accompanying drawings.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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International Bureau

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PCT

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(71) Applicant *(for all designated States except US)*: **THE UNIVERSITY OF SYDNEY** [AU/AU]; Parramatta Road, Sydney, NSW 2006 (AU).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **XU, Wei** [CN/AU]; Unit 5, 34 Talara Road, Gymea, NSW 2227 (AU). **WONG, Danny** [AU/AU]; 15 Sanders Road, Baulkham Hills, NSW 2153 (AU). **TOWN, Graham** [AU/AU]; 5 Victoria Street, Erskineville, NSW 2043 (AU). **CANNING, John** [AU/AU]; 10 Francis Street, Carlton, NSW 2218 (AU). **BLAZKIEWICZ, Paul** [AU/AU]; 8 Araluen Avenue, Moorebank, NSW 2170 (AU).

(74) Agent: **GRIFFITH HACK**; GPO Box 4164, Sydney, NSW 2001 (AU).

(81) Designated States *(national)*: AU, CA, JP, KR, US.

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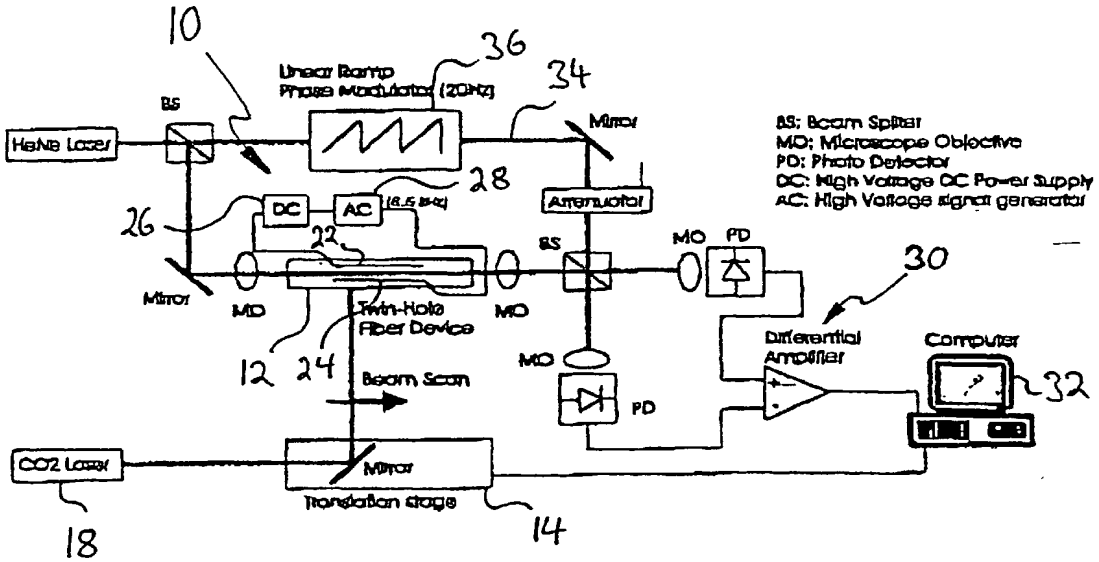
Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LASER ASSISTED THERMAL POLING OF SILICA BASED WAVEGUIDES



(57) Abstract: A method of thermally poling a silica based waveguide (12) comprises exposing a region of the waveguide (12) to an electric field (for example, via capillary electrodes (22, 24) inserted into holes in the waveguide); directing a laser beam (18) into the region exposed to the electric field to effect localised heating of the region via direct absorption; and scanning the laser beam (18) over the region at a rate selected to avoid heating of the region above the glass transition temperature. Reversing the electric field while scanning the laser beam (18) allows the formation of periodic poled gratings. The waveguide (12) can comprise an optical fibre.

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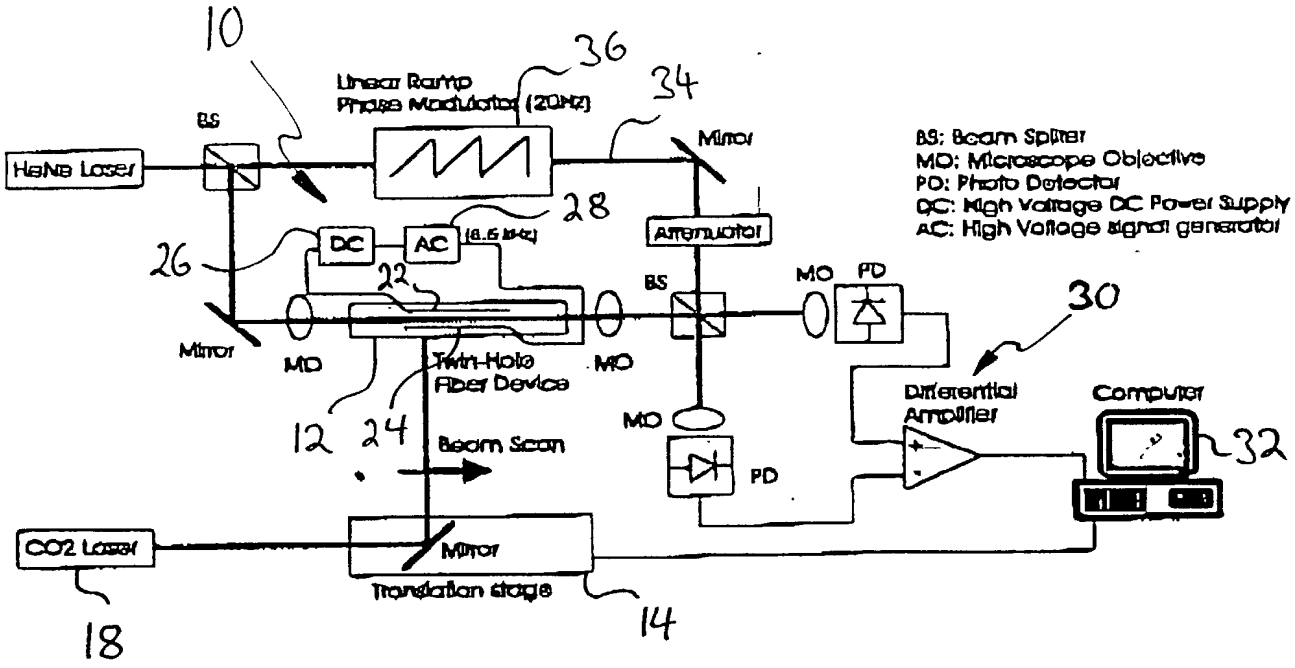

10
Linear Ramp
Phase Modulator (20Hz)
36
34
BS
HeNe Laser
Mirror
BS: Beam Splitter
MO: Microscope Objective
PD: Photo Detector
DC: High Voltage DC Power Supply
AC: High Voltage signal generator
28
DC
AC
(6.5 kHz)
Attenuator
26
22
BS
MO
PD
30
Mirror
MO
Twin-Hole
Fiber Device
MO
Differential
Amplifier
Computer
12
24
Beam Scan
MO
PD
32
CO2 Laser
Mirror
Translation stage
18
14

Figure 1

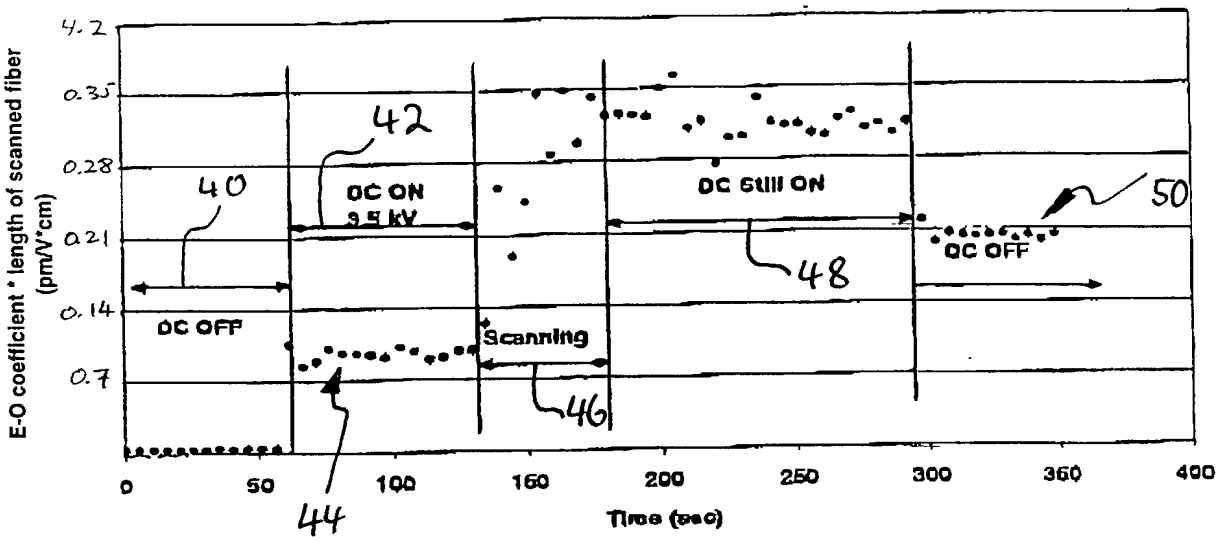
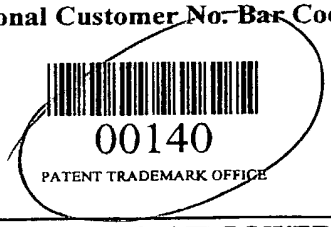

4.2
0.35
0.28
0.21
0.14
0.7
E-O coefficient * length of scanned fiber (pm/V*cm)
40
42
DC ON
3.5 kV
DC OFF
Scanning
DC still ON
48
50
DC OFF
46
44
0
50
100
150
200
250
300
350
400
Time (sec)

Figure 2

CRC 34-US {W.X D.W. P.B.

Practitioner's Docket No. U 013870-6 *PATENT*

Optional Customer No. Bar Code



COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

(check one applicable item below)

[ ] original.
[ ] design.

NOTE. *With the exception of a supplemental oath or declaration submitted in a reissue, a supplemental oath or declaration is not treated as an amendment under 37 CFR 1.312 (Amendments after allowance). M.P E.P Section 714.16, 7th Ed.*

[ ] supplemental.

NOTE. *If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.*

[X] national stage of PCT.

NOTE *If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.*

NOTE: *See 37 C.F.R. Section 1.63(d) (continued prosecution application) for use of a prior nonprovisional application declaration in the continuation or divisional application being filed on behalf of the same or fewer of the inventors named in the prior application.*

[ ] divisional.
[ ] continuation.

NOTE: *Where an application discloses and claims subject matter not disclosed in the prior application, or a continuation or divisional application names an inventor not named in the prior application, a continuation-in-part application must be filed under 37 C.F.R. Section 1 53(b) (application filing requirements-nonprovisional application).*

[ ] continuation-in-part (C-I-P).

INVENTORSHIP IDENTIFICATION

WARNING: *If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.*

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor *(if only one name is listed below)* or an original, first and joint inventor *(if plural names are listed below)* of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

LASER ASSISTED THERMAL POLING OF SILICA BASED WAVEGUIDES

SPECIFICATION IDENTIFICATION

The specification of which:

(complete (a), (b), or (c))

(a) [ ] is attached hereto.

NOTE. *"The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 C.F.R. Section 1 63.*

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed; or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) [ ] was filed on _____, [ ] as Application No. _____
[ ] and was amended on _____ (if applicable).

NOTE: *Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 C.F.R. Section 1.67.*

NOTE: *"The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 C.F.R. Section 1.63:*

(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);
(B) serial number and filing date;
(C) attorney docket number which was on the specification as filed;
(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or
(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration.

M.P.E.P § 601.01(a), 7th ed.

(c) [X] was described and claimed in PCT International Application No. AU00/01115 filed on September 14, 2000 and as amended under PCT Article 19 on _____*(if any)*.

SUPPLEMENTAL DECLARATION (37 C.F.R. Section 1.67(b))

(complete the following where a supplemental declaration is being submitted)

[ ] I hereby declare that the subject matter of the

[ ] attached amendment
[ ] amendment filed on _____.

was part of my/our invention and was invented before the filing date of the original application, above identified, for such invention.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, Section 1.56,

(also check the following items, if desired)

[ ] and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

[ ] in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 C.F.R. Section 1.98.

PRIORITY CLAIM (35 U.S.C. Section 119(a)-(d))

NOTE: 37 C.F.R. § 1.55 Claim for foreign priority.

"(a) An applicant in a nonprovisonal application may claim the benefit of the filing date of one or more prior foreign applications under the conditions specified in 35 U.S.C. 119(a) through (d) and (f), 172, and 365(a) and (b).

(1)(i) In an original application filed under 35 U.S.C. 111(a), the claim for priority must be presented during the pendency of the application,, and within the later of four months from the actual filing date of the application or sixteen months from the fling date of the prior foreign application. This time period is not extendable. The claim must identify the foreign application for which priority os claimed, as well as any foreign application for the same subject matter and having a filing date before that of the application for which priority is claimed, by specifying the application number, country (or intellectual property authority), day, month, and year of its filing. The time period in this paragraph does not apply to an application for a design patent.

(ii) In an application that entered the national stage from an international application after compliance with 35 U.S.C. 371, the claim for priority must be made during the pendency of the application and within the time limit set forth in the PCT and the Regulations under the PCT "

(2) The claim for priority and the certified copy of the foreign application specified in 35 U.S.C. 119(b) or PCT Rule 17 must, in any event, be filed before the patent is granted. If the claim for priority or the certified copy of the foreign application is filed after the date the issue fee is paid, it must be accompanied by the processing fee set forth in § 1.17(i), but the patent will not include the priority claim unless corrected by a certificate of correction under 35 U.S.C. 255 and § 1.323.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

(d) [ ] no such applications have been filed.
(e) [X] such applications have been filed as follows.

NOTE. Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. SECTION 119(a)-(d)

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
AU	PQ 2811	14 SEPTEMBER 1999	[X]YES [ ]NO
			[ ]YES [ ]NO
			[ ]YES [ ]NO
			[ ]YES [ ]NO
			[ ]YES [ ]NO

CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(35 U.S.C. Section 119(e))

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER	**FILING DATE**
_______/_______________________	___________
_______/_______________________	___________
_______/_______________________	___________

CLAIM FOR BENEFIT OF EARLIER U.S./PCT APPLICATION(S) UNDER 35 U.S.C. SECTION 120

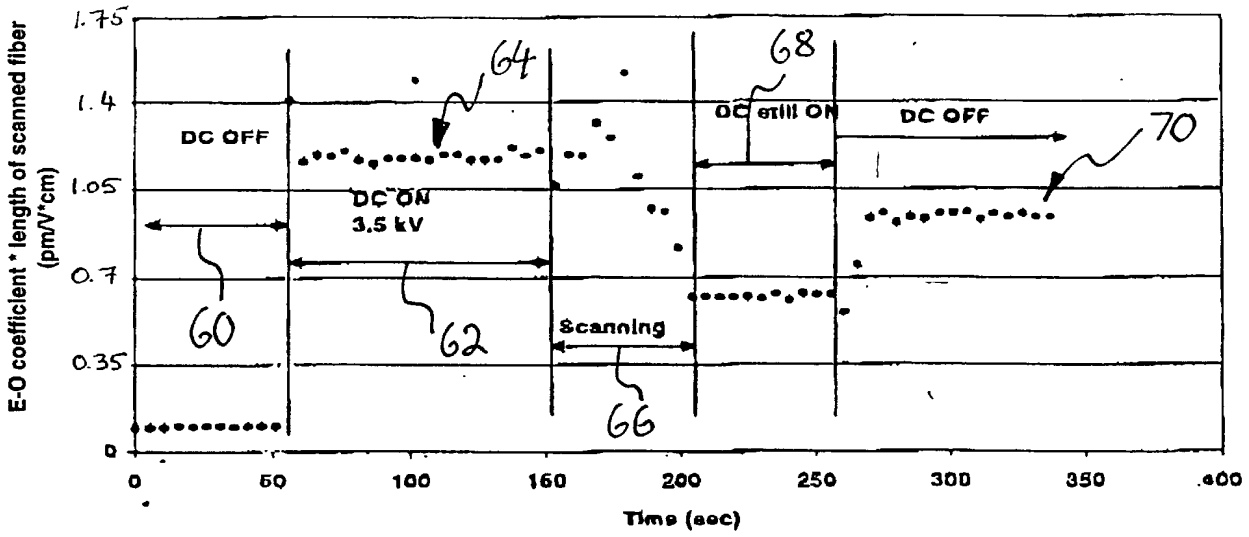


Figure 3

[ ] The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN-PART (C-I-P) APPLICATION.

ALL FOREIGN APPLICATION(S), *IF ANY*, FILED MORE THAN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

_____

_____

_____

NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. Section 120.

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

(list name and registration number)

JOSEPH H. HANDELMAN, 26179	JULIAN H. COHEN, 20302
JOHN RICHARDS, 31053	WILLIAM R. EVANS 25858
RICHARD J. STREIT, 25765	JANET I. CORD, 33778
PETER D. GALLOWAY, 27885	CLIFFORD J. MASS, 30086
RICHARD P. BERG, 28145	CYNTHIA R. MILLER, 34678

(Check the following item, if applicable)

[ ] I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

[ ] Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

NOTE: *"Special care should be taken in continuation or divisional applications to ensure that any change of correspondence address in a prior application is reflected in the continuation or divisional application. For example, where a copy of the oath or declaration from the prior application is submitted for a continuation or divisional application filed under 37 CFR 1 53(b) and the copy of the oath or declaration from the prior application designates an old correspondence address, the Office may not recognize, in the continuation or divisional application, the change of correspondence address made during the prosecution of the prior application. Applicant is required to identify the change of correspondence address in the continuation or divisional application to ensure that communications from the Office are mailed to the current correspondence address. 37 CFR 1.63(d)(4)." Section 601.03, M.P E.P , 7th Ed*

SEND CORRESPONDENCE TO

Ladas & Parry
26 West 61st Street
New York, N.Y. 10023

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)

WILLIAM R. EVANS
212-708-1930

(complete the following if applicable)

Since this filing is a [ ] continuation [ ] divisional there is attached hereto a Change of Correspondence Address so that there will be no question as to where the PTO should direct all correspondence.

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other document.

NOTE Each inventor must be identified by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and by his/her residence, post office address and country of citizenship. 37 C.F.R. Section 1.63(a)(3).

NOTE Inventors may execute separate declarations/oaths provided each declaration/oath sets forth all the inventors. Section 1.63(a)(3) requires that a declaration/oath, inter alia, identify each inventor and prohibits the execution of separate declarations/oaths which each sets forth only the name of the executing inventor. 62 Fed. Reg. 53,131, 53,142, October 10, 1997,

Full name of sole or first inventor

1-00

Wei _____ _____ Xu
(Given Name) *(Middle Initial or Name)* *Family (Or Last Name)*

Inventor's signature (x) _____

Date (x) APRIL 19, 2002 **Country of Citizenship** China/Australia

Residence ~~Unit 5, 34 Talara Road, Gymea, NSW 2227, Australia~~ UNIT 6, 15-17 PRINGLE AVE, BANKSTOWN NSW 2200, AUSTRALIA Aux

Post Office Address Same as above

Full name of second joint inventor, if any

2-00

Danny _____ _____ Wong
(Given Name) *(Middle Initial or Name)* *Family (Or Last Name)*

Inventor's signature (x) _____

Date (x) April 20, 2002 **Country of Citizenship** Australia

Residence 15 Sanders Road, Baulkham Hills, NSW 2153, Australia Aux

Post Office Address Same as above

3-00

Full name of third joint inventor, if any

Graham _____ _____ Town
(Given Name) *(Middle Initial or Name)* *Family (Or Last Name)*

Inventor's signature (x) _____

Date (x) _____ **Country of Citizenship** Australia

Residence 5 Victoria Street, Erskineville, NSW 2043, Australia Aux

Post Office Address Same as above

SIGNATURE(S)

NOTE. Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other document.

NOTE. Each inventor must be identified by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and by his/her residence, post office address and country of citizenship. 37 C.F.R. Section 1.63(a)(3).

NOTE: Inventors may execute separate declarations/oaths provided each declaration/oath sets forth all the inventors. Section 1.63(a)(3) requires that a declaration/oath, inter alia, identify each inventor and prohibits the execution of separate declarations/oaths which each sets forth only the name of the executing inventor. 62 Fed. Reg. 53,131, 53,142, October 10, 1997,

Full name of sole or first inventor

Wei (*Given Name*) | (*Middle Initial or Name*) | Xu (*Family (Or Last Name)*)

Inventor's signature (x) _____

Date (x) _____ **Country of Citizenship** China/Australia

Residence Unit 5, 34 Talara Road, Gymea, NSW 2227, Australia

Post Office Address Same

Coded on page 1

Full name of second joint inv

Danny (*Given Name*) | Wong (*Or Last Name*)

Inventor's signature (x) _____

Date (x) _____

Residence 15 Sanders Road, F

Post Office Address Same

Full name of third joint inventor, if any

Graham (*Given Name*) | E (*Middle Initial or Name*) | Town (*Family (Or Last Name)*)

Inventor's signature (x) _____

Date (x) 30/4/02 **Country of Citizenship** Australia

Residence 5 Victoria Street, Erskineville, NSW 2043, Australia

Post Office Address Same as above

Practitioner's Docket No. U 013870-5

ADDED PAGE TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR SIGNATURE BY FOURTH AND SUBSEQUENT INVENTORS

Full name of fourth joint inventor, if any

4-00

John (Given Name) _____ (Middle Initial or Name) Canning (Family (Or Last Name))

Inventor's signature (x) J. Canning

Date (x) _____ **Country of Citizenship** Australia

Residence 10 Francis Street, Carlton NSW 2218, Australia AUX

Post Office Address Same as above

Full name of fifth joint inventor, if any

5-00

Paul (Given Name) _____ (Middle Initial or Name) Blazkiewicz (Family (Or Last Name))

Inventor's signature (x) _____

Date (x) _____ **Country of Citizenship** Australia

Residence 8 Araluen Avenue, Moorebank, NSW 2170, Australia AUX

Post Office Address Same as above

Full name of sixth joint inventor, if any

(Given Name) _____ (Middle Initial or Name) _____ Family (Or Last Name) _____

Inventor's signature _____

Date _____ **Country of Citizenship** _____

Residence _____

Post Office Address _____

Practitioner's Docket No. U 013870-6

ADDED PAGE TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR SIGNATURE BY FOURTH AND SUBSEQUENT INVENTORS

Full name of fourth joint inventor, if any

John (*Given Name*) _____ (*Middle Initial or Name*) Canning (*Family (Or Last Name)*)

Inventor's signature (x) _____

Date (x) _____ **Country of Citizenship** Australia

Residence 10 Francis Street, Carlton NSW 2218, Australia

Post Office Address Same as above

Full name of fifth joint inventor, if any

Paul (*Given Name*) _____ (*Middle Initial or Name*) Blazkiewicz (*Family (Or Last Name)*)

Inventor's signature (x) P. Blazkiewicz

Date (x) 4/19/02 **Country of Citizenship** Australia

Residence 8 Araluen Avenue, Moorebank, NSW 2170, Australia

Post Office Address Same as above

Full name of sixth joint inventor, if any

_____ (*Given Name*) _____ (*Middle Initial or Name*) _____ (*Family (Or Last Name)*)

Inventor's signature _____

Date _____ **Country of Citizenship** _____

Residence _____

Post Office Address _____

(check proper box(es) for any of the following added page(s) that form a part of this declaration)

[x] **Signature** for fourth and subsequent joint inventors. *Number of pages added* ____1____

* * *

[ ] **Signature** by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added* _____

* * *

[ ] **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 C.F.R. Section 1.47. *Number of pages added* _____

* * *

[ ] Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 C.F.R. Section 1.47)

* * *

[ ] Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

[ ] Number of pages added _____

* * *

[ ] Authorization of practitioner(s) to accept and follow instructions from representative.

(If no further pages form a part of this Declaration, then end this Declaration with this page and check the following item)

[ ] This declaration ends with this page.